Base Requirements for Virtual Tabletop Groupware Artifacts

Tobias Müller[1], Karsten Nebe[2], Florian Klompmaker[3]

Heinz Nixdorf Institute, University of Paderborn[1]
Rhine-Waal University of Applied Sciences[2]
C-Lab, University of Paderborn[3]

Abstract

Group work is a crucial part of our everyday life. While individual work is already relatively well supported by computerized tools, co-located group work is still missing an adequate support. To enable a continuous support over all stages of work, it is desirable to close this gap. In this paper we present a survey on requirements which virtual artifacts in tabletop groupware have to fulfill to fully support co-located group work. We conducted interviews with students to determine when and how they use group work and derived requirements for virtual artifacts from these results. Based on existing literature on this field of work further requirements have been identified. These were combined with our analysis results and were transformed into a set of eight independent base requirements virtual artifacts must fulfill.

1 Motivation and Introduction

Ordinary computers are designed for single user usage and do not support collaborative and social aspects – features, which are known as co-located groupware – in an adequate way. When co-located group work becomes necessary, people can either restrain themselves to the restrictions of current soft- and hardware or fall back on traditional tools, e.g. such as paper and pen, white boards, etc. For these tools the utilization is obvious to everybody. The major problem we want to address in this work is that in many group work situations in which digital media are used, the dilemma exists that people can basically just choose between two options. The first one is to continuously work with digital systems, the same tools they use in daily business. This way they can use all the features of current software but have a poor support for co-located group work. The second option is to work with analogue media, which suit the group work needs but do not provide the beneficial features of digital media. In many cases they also require a forced change of the working media, e.g. transforming the digital media in analogue media by printing.

This paper shows first ideas and results on how this dilemma can be solved by using tabletop groupware (TG). We concentrate on the digital media and present a set of eight independent requirements virtual TG artifacts must fulfill. We performed a user and task analysis of a group work scenario in which this dilemma occurs and changes of the working media are needed to fully support the group work needs. Then we combined the results of our study with existing requirements based on literature of co-located groupware into a set of requirements the included virtual artifacts must fulfill.

2   Usage Scenario and Analysis

In order to be able to define requirements for TG artifacts, first the identification of a reasonable usage scenario is needed. Therefore we chose a common real-life scenario, which exists in practice: Today students often work together for a longer period of time in order to prepare a talk or to create a paper. Typically this kind of groups consists of two to five people and the group work stretches over one term, i.e. three to four month. Based on this group work scenario we conducted interviews to gather detailed information on how the group work is performed, what is done together as a group, what is done individually and which kinds of real world artifacts are used during group meetings. Overall six students were interviewed about their experience with group work during their studies. Each interview was separated in two parts. The focus of the first one was on the organizational part of the group work, like how often they meet, which work is done within the group or which work was done alone. This helped to get a detailed view on the requirements implicated by the process of the group work and which types of tasks are performed during this time. The second part was about the artifacts the students use to organize their information.

As a result it became apparent that organizing information, reconciling work results and discussions about results as well as decisions about further actions are generally done as part of group work. Creating texts, graphics or slides or doing (long-winded) research is done more often individually. This leads to the conclusion that a tabletop system for co-located collaborative group work especially needs to support working with previously created information and less with the creation of many new artifacts. Thus TG solutions adopted for this kind of group work must provide the ability to exchange artifacts between users, support specialized types of artifacts and should favor functions for working with existing artifacts over functions for creating new artifacts. Another result from the interviews is that there is a set of artifact types that are typically used during group work in this usage scenario. Such types are plain paper, tables, lists, texts and a blackboard. These types should have a counterpart in a digital solution to fit the users' needs and their way of working. As the number of interviewed students is relatively low, this set can only be seen as an initial suggestion but not as a wholesale list.

3 Identified Base Requirements for TG Artifacts

Beside the requirements for virtual artifacts which could be derived from the interviews, information from existing publications needs to be taken into account. This is due to the fact that a lot of research has already been made concerning specific aspects, e.g. rotation of artifacts (Kruger et al. 2003; Kruger et al. 2004) which are not covered by our interviews. Some publications also directly support the findings from our interviews; however they do not make them redundant. The following list contains the eight base requirements we were able to identify.

Artifacts must be equally accessible, share-, and exchangeable: The artifacts must be shareable and distributable among the group members and it must be equally possible for them to gain control over the shared artifacts. This becomes necessary because of what we know from the interviews about how the results and information from the single work are organized and work results are reconciled. It is also important for the group to be able to change between highly and loosely-coupled work (Scott et al. 2003). The access must be equal because otherwise the members with the lesser control will be pushed aside and by tendency neglected during the group discussion (Inkpen et al. 2001; Marshall et al. 2007).

Functions for working with existing artifacts must be favored over functions for creating new artifacts: As we know from our interviews, most of the media will be created or collected in single work anyway and during the group meetings, these artifacts will be modified, discussed or redistributed but not likely created in a great amount. Thus the functions for working with artifacts are used more often in a group context.

Specialized types of artifacts must be provided: Different types of artifacts which are specialized for different kinds of information must be part of an adequate solution. Based on the results from our interviews we suggest including at least the types plain paper for simple drawing, text for text editing, a sort of blackboard, tables and lists. Other authors (Leonardi et al. 2009) also suggest using an agenda items list and an outcomes notes list.

Artifacts must be independent from each other: The independency is necessary for two reasons. One reason is the way group work changes over time. The group members tend to go from a highly coupled group work to a loosely coupled group work and vice versa many times during a session. Every time, the group falls apart, these subgroups or single group members must be able to keep on working without interfering with each other for technical causes (Scott et al. 2003; Tang et al. 2006). The other reason is that when many users interact with the table at once, they always need to be able to work simultaneously. If the artifacts were coupled, the simultaneous work could interfere with each other and again interrupt the group process (Scott et al. 2003; Tang et al. 2006).

Continuous, incremental and immediate manipulation must be enabled for the artifacts: Whenever possible the control of the artifacts must be build up on continuous manipulation, not just on symbolic gestures. This especially means, that an action of a user should result in a continuous incremental change of the artifact and that the behavior of the artifacts should be part of a consistent model-world (Jetter et al. 2010).

Artifacts must be arbitrarily move- and rotatable on an individual basis: The position and orientation of the artifacts must be arbitrarily move- and rotatable which is important for different reasons (Kruger et al. 2003; Kruger et al. 2004). It helps to support the understanding as the group members can (re-)arrange everything to new views. Another reason is the communication as humans often use rotation and movement as a means of communication. The third one is the coordination. If an item is close to a person and turned towards this person, it is defined as a private item while if it is rotated to the center of the table or even in the center, it is currently subject to the group's discussion. People also take totally different positions and tend to change them over time (Scott et al. 2003). So it must be easily possible to relocate and reorient the artifacts depending on the positions of the group members. All these manipulations must be made continuously for the group members to be easily able to follow the movements (Kruger et al. 2003; Kruger et al. 2004).

Interference while manipulating artifacts must be minimized: If artifacts are moved or resized, their interference with other artifacts should be minimized. This can be done by e.g. turning them semi-transparent during the interaction or when actual interference is detected (Zanella & Greenberg 2001).

Access conflicts must be handled: So far there are still different views on the resolution of conflicts, i.e. when two users try to execute conflicting actions on an artifact. One possible view is to let software resolve conflicts or at least minimize the effects. The respective authors (Ringel Morris 2006; Nacenta et al. 2007; Pinelle at al. 2008) argue, that this way the group members are released from the obstruction caused by conflicts and thus can concentrate more on the actual work. Other authors instead (Hornecker et al. 2007; Tang et al. 2006) argue that conflicts are a symptom of a problem that needs a closer collaboration of the group members. Even though we cannot make a final assessment on this, either way must be supported.

4   Summary and Future Work

Even though large progress has been made in research during the last years, it is still not perfectly clear how to integrate digital media into co-located group work in an appropriate way. This becomes necessary because a lot of individual work is already done by using computers on one's own and there is a need to share results. Especially when it comes to the adequate virtual artifacts for co-located group work there is still a lack of knowledge about the requirements. To be able to design an environment to support co-located group work with digital media appropriately, this gap needs to be closed.

With our study we were able to identify requirements for a scenario of students' group work. We did this by interviewing students about the way they work and were able to determine that they do a lot of work as individual work even if the task is to perform group work. They meet to synchronize results, coordinate and distribute their work again. Based on this situation we derived requirements from interviews and combined them with further requirements

based on a literature analysis. As a result we identified eight base requirements, which TG artifacts must fulfill to properly support the given co-located group work scenario.

By now the identified requirements are still tied to a narrow usage scenario. Thus in future we will examine in how far the requirements change if the background of the group work changes, e.g. from creating a paper to learning together for a tests. Our aim is to identify overall stable requirements. We will also extend the base requirements towards the overall process of group work including individual work. We especially will closer examine the integration of the co-located group work and the individual work. One emphasis which we didn't address yet will be how the artifacts from the single work relate to the artifacts in a group situation. Another emphasis will be on how annotations can be used to manage extra information and changes can be tracked in an adequate way. The long term goal is to be able to define a digitally supported environment which continuously includes the whole process of learning and studying in a group.

References

Hornecker, E., Marshall, P., Dalton, N. S. & Rogers, Y. (2008). *Collaboration and interference: Awareness with mice or touch input.* In Proceedings of ACM CSCW Conference 2008. ACM, New York, NY, USA. Pp. 167–176.

Inkpen, K. M., Hancock, M. S., Mandryk, R. L. & Scott, S. D. (2001). *Collaboration around a tabletop display: Supporting interpersonal interactions*. In SFU Tech Report.

Jetter, H.-C., Gerken, J. & Reiterer, H. (2010). *Natural user interfaces: Why we need better model-worlds, not better gestures.* Presented at: CHI 2010 Workshop - Natural User Interfaces: The Prospect and Challenge of Touch and Gestural Computing, Atlanta, USA

Kruger, R., Carpendale, M. S. T., Scott, S. D. & Greenberg, S. (2003). *How people use orientation on tables: comprehension, coordination and communication.* In Schmidt, K., Pendergast, M., Tremaine, M. & Simone, C. (eds.): ACM, New York, NY, USA. Pp. 369–378.

Kruger, R., Carpendale, M. S. T., Scott, S. D. & Greenberg, S. (2004). *Roles of orientation in tabletop collaboration: Comprehension, coordination and communication.* In Computer Supported Cooperative Work 13(5-6). Kluwer Academic Publishers, Norwell, MA, USA. Pp. 501–537

Leonardi, C., Pianesi, F., Tomasini, D. & Zancanaro, M (2009). *The collaborative workspace: A co-located tabletop device to support meetings.* In Waibel, A. H. & Stiefelhagen, R. (eds.) : Computers in the Human Interaction Loop, Human-Computer Interaction Series. Springer, Heidelberg. Pp. 187–205.

Marshall, P. Rogers, Y. & Hornecker, E. (2007). *Are tangible interfaces really any better than other kinds of interfaces?* Presented at: The Workshop on Tangible User Interfaces in Context and Theory at CHI 2007. San Jose, California, USA

Nacenta, M. A., Pinelle, D., Stuckel, D., & Gutwin, C. (2007). *The effects of interaction technique on coordination in tabletop groupware*. In Healey, C. G. & Lank, E. (eds.): Graphics Interface, volume 234 of ACM International Conference Proceeding Series. ACM, New York, NY, USA. Pp. 191–198.

Pinelle, D., Nacenta, M. A., Gutwin, C. & Stach, T. (2008). *The effects of co-present embodiments on awareness and collaboration in tabletop groupware.* In Shaw, C. & Bartram, L. (eds.): Graphics Interface, ACM International Conference Proceeding Series. ACM, New York, NY, USA. Pp. 1–8.

Ringel Morris, M. (2006). *Supporting effective interaction with tabletop groupware.* In Proceedings of the First IEEE International Workshop on Horizontal Interactive Human-Computer Systems. IEEE Computer Society. Stanford, California, USA. Pp. 55–56.

Scott, S. D., Grant, K. D. & Mandryk, R. L. (2003). *System guidelines for co-located, collaborative work on a tabletop display.* In Kuuti, K., Kartsen, E. H., Fitzpatrick, G., Dourish, P. & Schmidt, K. (eds.): Proceedings of the Eight European Conference on Computer-Supported Cooperative Work. Kluwer Academic Publishers, Norwell, MA, USA. Pp. 159–178

Tang, A., Tory, M., Po, B., Neumann, P. & Carpendale, S. (2006). *Collaborative coupling over tabletop displays.* In Nichols, J. A. & Schneider, M. L. (eds.): Proceedings of the SIGCHI conference on Human factors in computing systems (CHI 2006). ACM, New York, NY, USA. Pp. 1181–1190.

Zanella, A. & Greenberg, S. (2001). *Reducing interference in single display groupware through transparency.* In Prinz, W., Jarke, M., Rogers, Y., Schmidt, K. & Wulf, V. (eds.): ECSCW. Kluwer Academic Publishers Norwell, MA, USA. Pp. 339–358.

Contact

Tobias Müller
Heinz Nixdorf Institute|
University of Paderborn

tmueller@upb.de